

DR. PUGH'S HERBARIUM

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ABSTRACT

Evan Pugh, a young and talented agricultural chemist from Pennsylvania, produced important discoveries on the role of plants in the fixation of atmospheric nitrogen during three years of study and research, conducted in England from 1856–59. He then returned home as the first president of what is now the Pennsylvania State University, not only the youngest, but also the most talented president the institution has ever had. Arriving in 1859 to take up his new duties, he brought with him plant specimens he had collected during a several months' visit to the Heidelberg area of Germany in 1856, and also much of the herbarium of Professor G.W. Bischoff of Heidelberg, which he bought while there. It is clear that Pugh wanted the new college to become an important center for agricultural research and thought a herbarium was an essential asset for such research. Pugh died in 1864, but W.A. Buckhout, a student of Asa Gray at Harvard, took over botany, horticulture and the responsibility for the Pugh herbarium at Penn State in 1872. The intimate connection between that herbarium and the founding of a university is unique.

RESUMEN

Evan Pugh, un inteligente joven químico agrícola de Pensilvania, produjo importantes descubrimientos en el papel de las plantas en la fijación del nitrógeno atmosférico en tres años de estudio e investigación, realizada en Inglaterra durante 1856–59. Entonces regresó como el primer presidente de lo que ahora es la Universidad Estatal de Pensilvania, siendo no solo el más joven, sino también el presidente más inteligente que la institución haya tenido. Llegó en 1859 para emprender sus nuevos deberes, trajo consigo especímenes de plantas que había colectado durante la visita de varios meses al área de Heidelberg en Alemania en 1856, y también gran parte del herbario del Profesor G.W. Bischoff de Heidelberg, que compró mientras estaba allí. Está claro que Pugh quería que la nueva universidad se convirtiera en un centro importante de investigación agrícola y pensó que un herbario era un activo esencial para tal investigación. Pugh murió en 1864, pero W.A. Buckhout, un estudiante de Asa Gray en Harvard, se quedó a cargo de la botánica, horticultura y la responsabilidad del herbario Pugh en la Penn State en 1872. La conexión íntima entre el herbario y la fundación de una universidad es única.

BACKGROUND

In 1868, the new Pennsylvania College of Agriculture in Centre County (now the Pennsylvania State University) was in pitiful condition. The tragic death in 1864 of the young, very talented first president, Evan Pugh, and the departure of many of the students for the American Civil War in 1863–65 were nearly fatal to the infant college. The administration called for an inventory of everything of value that the college possessed. On the not especially noteworthy list was "Dr. Pugh's European Herbarium" (Fig. 1).

The original heart of the Penn State Herbarium, Dr. Pugh's collection still exists and is now located in 13 Whitmore Lab. Aside from the old Presidents' House, which Pugh partly financed from his own pocket, and the construction of which he oversaw right up to his death, the Pugh herbarium is the most personal relic of Evan Pugh's presence here, other than some boxes of his correspondence and a handful of books from his library, which are in the Penn State Archives.

Pugh's herbarium is not only still extant, it is in constant use, expanded from the approximately 3,000 original specimens from Pugh to 107,000 now. It is known in the scientific literature, as are all herbaria recognized by *Index Herbariorum* (Thiers 2008) by an acronym, in this case, "PAC," for Pennsylvania Agricultural College. That is approximately the same name used on the labels in Dr. Pugh's herbarium, "Agricultural College of Pennsylvania," which Pugh substituted for "Farmers High School," the name of the institution founded in 1855 that he took over in 1859.

Page from the Pennsylvania Agricultural College
Inventory of January , 1868.

One Articulated Skeleton, and one Loose Skeleton, for Instruction in Human Anatomy and Physiology,
 Diagrams to Illustrate Human Anatomy and Physiology,
 → Dr. Pugh's European Herbarium,
 An Air Pump, Electrical Machine, &c.,
 A very good assortment of Apparatus and other Appliances for Class-room and Laboratory Instructions in Chemistry,
 A Surveyor's Compass, Chains and Pins,
 A Rail Road Transit Rail Road Level and Graduated Staff,
 The use of Prof. James Clark's private Zoological Collection,
 A Mason & Hamin's Organ,

FIG. 1. Page from the 1868 emergency inventory of the possessions of the Pennsylvania College of Agriculture. Dr. Pugh's herbarium (see arrow) was obviously regarded as a significant asset.

It is clear from Pugh's correspondence that he wanted the new college in rural Pennsylvania to become an important center for agricultural research, and he regarded a herbarium as an essential asset for the aspects of such research that depended on a breadth of botanical knowledge and information. His herbarium is also more personal than the house he built but never lived in, since he obviously handled each and every plant specimen that he collected, purchased, or otherwise obtained while in Heidelberg, Germany, in the spring and summer of 1856. Among other things, the Pugh specimens demonstrate dramatically the durability of herbarium specimens. Despite the many vicissitudes of the collection in Germany, the voyage to America, and the early days at Penn State, most of the Pugh plants remain in excellent condition (Fig. 2).

Especially noteworthy in this connection are some specimens that Pugh obtained from the herbarium of G.W. Bischoff, Professor of Botany at Heidelberg. They survived collection in various parts of the world, shipping to Germany and then shipping again to the rather primitive environment of Centre County, Pennsylvania, to a nascent institution in open farmland, fifteen miles from the nearest city, with no finished building to receive the pressed plant collection.

Evan Pugh was not only the first president of what became Penn State University, he was also the youngest and unquestionably the most talented president the institution has ever had (Fig. 3). Had he not died at the early age of 36, it is certain that his impact on American education and science would eventually have rivaled that of the legendary American college presidents of the 19th century, luminaries such as Charles W. Eliot of Harvard. In science, his biochemical work in Germany, and especially in England, on the fixing of nitrogen by plants, was widely acclaimed. His early correspondence as president of the nascent Pennsylvania college shows that he was having an impact in the political/educational arena of America. For example, he persuaded others of the importance of the developments leading to the Morrill Act of 1863, which set up a funding system for what became the "Land Grant Colleges." This was most dramatically displayed in Pugh's actions in assuring that the funds accruing to education in Pennsylvania from the Act would go to Penn State and only to Penn State.

On one of the sheets of a herbarium specimen Pugh collected in Heidelberg, he noted that the specimen was "collected for W. H. Brewer." Brewer and Pugh were in Heidelberg at the same time—the summer of 1856—and both did extensive botanizing that summer in central Europe. Brewer later became head of the Agricultural Department at the Sheffield Scientific School at Yale, but at the time Pugh arrived at the nascent



FIG. 2. One of Evan Pugh's collections from the Heidelberg area in the summer of 1856 and next to it (right), a specimen of the same species (*Lathyrus pratensis* L.) collected by a German botanist, Ulrich Kull, in the same province of Germany in 2012, illustrating the durability of herbarium specimens, even over 157 years of rather challenging experiences—providing the specimens are kept dry and protected from cellulose-consuming events and animals.

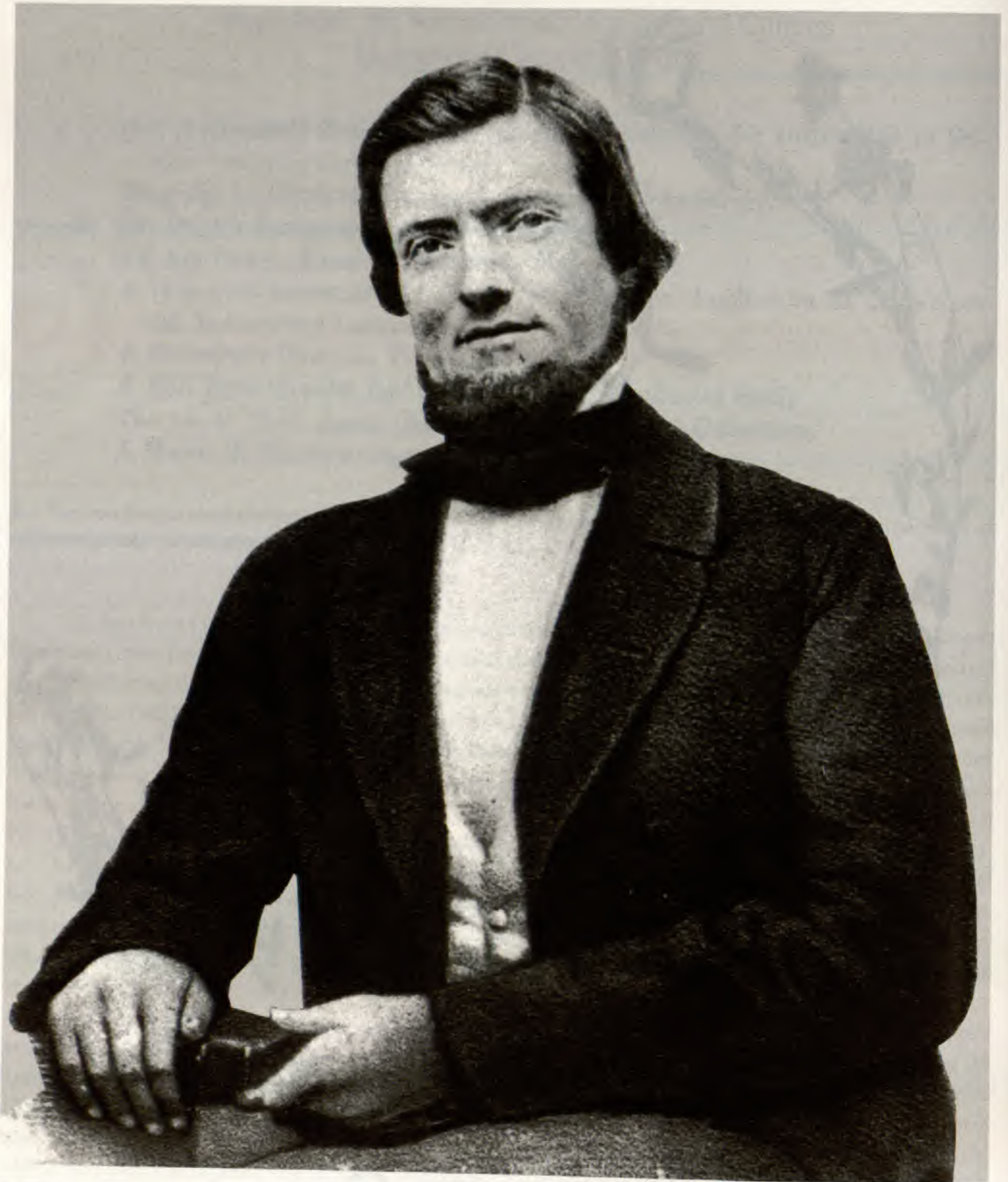


FIG. 3. Dr. Evan Pugh, Penn State's first president, as he looked at the time he arrived back in Pennsylvania from his years in Europe, in 1859. He was a big man, well over six feet tall.

Penn State in 1859, Brewer was Professor of Chemistry at what is now Washington and Jefferson College in Washington, Pennsylvania. Brewer was an outstanding scientist. Presumably he and Pugh remained in close touch back home in Pennsylvania, for example, on such matters as the move toward the Morrill Land Grant legislation.

Pugh was a chemist, but one whose interests were broad, and whose most important research was con-

nected to plants. His early education, through what we would consider high school, was in various private schools in eastern Pennsylvania and New York, with heavy emphasis on languages, mathematics, and the sciences. He then taught in an elementary school and subsequently became principal of an academy, both in the Philadelphia area. By 1853, at age 25, he had inherited a considerable fortune and was able to travel to Europe and spend the next three years at the German universities of Leipzig and Göttingen.

After completion of his doctoral dissertation, which dealt mostly with mineralogical chemistry, at Göttingen in early 1856, he accepted a research position in the renowned laboratories at Rothamsted Experimental Station, England, where he worked for several years, beginning in the Fall of 1856. He made significant discoveries there, showing that certain plants can take nitrogen from the atmosphere and incorporate it into their chemical structure. This is a critical matter to Earth's biochemistry, as it explains how plants can produce proteins independently from those they can absorb from the soil. It has been suggested that if research of such significance were published today, the author would likely get a Nobel prize or share one with co-authors. The critical paper was Lawes, Gilbert and Pugh, 1862. Pugh was invited to lecture on this research by the British Chemical Society and was made a fellow of the Society in reaction to the significance of his discoveries. Later, the importance of his early scientific work was overshadowed by his accomplishment in turning "Farmers High School" into the forerunner of the great American Land Grant universities. Over the years, the great significance of his work with plant fixation of nitrogen has occasionally been noted in the literature (e.g., Browne 1930).

During the Spring and Summer of 1856, before Pugh went to Rothamsted, he spent several months in Heidelberg. Why he went there is not certain. A letter home commented that his laboratory in Heidelberg was the best he had ever had in Germany and that he loved the countryside around this storied University. The chief chemist there at the time was Robert W. E. Bunsen of Bunsen-burner fame, but I have found no evidence that Pugh worked with him. One thing is certain about Pugh's time in Heidelberg: he did much plant collecting and was in contact with the botanical personalities of that time and place. It seems likely that the purpose of the sojourn in Heidelberg was botanical. Pugh would certainly need to enrich his botanical knowledge to accompany his mastery of chemistry, to be prepared for work at an agricultural college in the mid-19th century. Producing a herbarium would be an important part of what he took back to America from Europe. Many of the plants for this purpose were collected by Pugh himself in parts of Baden-Württemberg near Heidelberg. Furthermore, and very important, is that one of the leading botanists in Germany of the time, G.W. Bischoff (1797–1854), was Professor of Botany at Heidelberg University and Director of the Heidelberg Botanical Garden. Bischoff died not long before Pugh had finished his doctorate at Göttingen and headed for Heidelberg. Bischoff's herbarium was sold at auction in Heidelberg on 21 July 1856, and Pugh bought a considerable part of it. Those plant specimens, for the most part clearly marked with both Bischoff's and Pugh's names, plus Pugh's own collections of 1856 from the Heidelberg area—including a number from the famous Heidelberg Botanical Garden—plus many specimens that he somehow obtained from other German collectors, make up "Dr. Pugh's European Herbarium" that he shipped to America (Figs. 2, 4–7).

One significant aspect of "Dr. Pugh's Herbarium" is that Heidelberg's Professor Bischoff was a prodigious collector of plants, having made collecting forays from about 1820 to about 1850 to various parts of the world—South Africa, South America, etc. On at least two of his trips he collected in or near Pennsylvania. There are a number of sheets in the Pugh herbarium with labels indicating that the specimens were collected in the vicinity of Reading, Pennsylvania, in 1831 and in New Jersey in 1849 (Figs. 5, 6 & 7). (Coincidentally, Evan Pugh was born and raised in Oxford, a small rural town in southeastern Pennsylvania, less than 50 miles south of Reading and the same distance west of New Jersey.) The American Bischoff specimens would have crossed the Atlantic with Bischoff to Europe in a sailing vessel, and then after some years in the botanical collections in Heidelberg, been bought by Pugh in 1856, and shipped back across the Atlantic, this time probably by steamship, eventually ending up in the Penn State Herbarium.

In one of his letters, Pugh mentioned shipping a crate of rocks and minerals from Göttingen to relatives in the Philadelphia area, presumably samples from his Ph.D. work. It seems probable that he arranged the same

1347 (now *Cryptogramma crista*): original label: *Onoclea crista*
(Tyrol)
Oetzthal, zwischen Oetz und Umhausen 1823



1347
Pennsylvania
State University
Herbarium

= *Cryptogramma crista* (L.) R. Br.
M. H. Manuel Aug. 1975

AGRICULTURAL COLLEGE OF PENNSYLVANIA.

Onoclea crista.

(Tyrol)

Oetzthal, zwischen Oetz und
Umhausen.
1823.

Pteris crista.

Bischoff's Collection,

E. Pugh, Heidelberg.

FIG. 4. Typical example of the herbarium specimens purchased by Pugh in 1856 from the estate of the prominent Heidelberg botanist, Prof. G.W. Bischoff. Note that Bischoff's label, on the left, is written in an outmoded form of German handwriting, not used since the 1930s. The specimen is a fern from Tyrol, Austria, collected by Bischoff in 1823.

AGRICULTURAL COLLEGE OF PENNSYLVANIA.

Asplenium thelypteroides Mx.
Bischoffs Collection.

E. Pugh, Heidelberg



Depernia acrostichoides (Sw.) M. Kato

Asplenium thelypteroides Michx.
————— *acrostichoides* Sw.

Berks Co.

1696



In sylvis umbrosis prope
Reading Pennsylvaniae.

1831. J. G. Bischoff misit

FIG. 5. Herbarium specimen of a fern collected by Bischoff in Reading, PA, in 1831. PAC has many such specimens that crossed the Atlantic with Bischoff enroute to Germany, then back across it in 1859, with the rest of Pugh's herbarium.

Woodwardia virginica Swartz
 syn. fil. p. 117. Willd. sp. V. p. 418.
 (A. Gray man. p. 626.)

In uliginosis prope Tuckerton
 Novae Caesariae,
 leg. G. G. Bischoff, Jul. 1848.
 mis. 1849



AGRICULTURAL COLLEGE OF PENNSYLVANIA.

in a swamp, Tuckerton, NJ Woodwardia Virginia,

Bischoff's Collection,



E. Pugh, Heidelberg

FIG. 6. Specimen of a fern collected by Bischoff in 1849 on one of his many foreign collecting trips. Original label in Bischoff's easily recognized handwriting, upper left. "Novae Caesariae" is the genitive form of Nova Caesarea, the name of New Jersey in Latin. Dr. Pugh's herbarium included hundreds of Bischoff plants from over much of the world: South Africa, South America, Cuba, Java, etc.



4515
 Pennsylvania
 State University
 Herbarium

AGRICULTURAL COLLEGE OF PENNSYLVANIA.
Orchis maculata L.
 Handbuchheim.
 Near Heidelberg.
 June 8th 1856.
 E. Pugh. Heidelberg.

FIG. 7. Specimen of an orchid collected by Pugh in the Spring of 1856, in the Baden-Württemberg area, when he was obviously very busy expanding coverage of his herbarium. Note that the label, ostensibly by Pugh, is actually a reworking of Pugh's data in about 1875, by W.A. Buckhout, when he was Head of the Department of Botany and Horticulture at Penn State.

sort of shipment to Philadelphia of what would have been at least two or three large steamer trunks containing the infant Penn State herbarium. There, relatives would have been available to help him with further moving chores. Such modern-sounding shipment was apparently quite ordinary in 1856. The journey of the crates or trunks full of plant specimens from Heidelberg, probably to Rotterdam, then by sail or steamer to Philadelphia, and eventually by train to Bellefonte, Pennsylvania, and by some sort of horse-drawn vehicle the last ten miles or so to State College, before there even was a State College or a significant road to the area, is fascinating to contemplate.

EVAN PUGH AT THE PENNSYLVANIA AGRICULTURAL COLLEGE

Dr. Pugh arrived in Centre County in 1859 to head up the Farmers High School, which he soon renamed Agricultural College of Pennsylvania. (It became Pennsylvania State College in 1874 and Pennsylvania State University in 1953.) Pugh's first job was to rescue the then floundering agricultural college, beginning with securing funding for completion of the first, and for some time only, permanent building, the original Old Main. The herbarium would have been kept in that building, which also provided classrooms, laboratories, dormitories, refectory, and so on. It was constructed of Ordovician dolomite, quarried near the building. Students provided much of the labor as part of their program. The ground plans for the structure show several small rooms labeled "Museum." Presumably, the herbarium would have been kept in one of those rooms.

Evan Pugh died in 1864, some weeks after he had a disastrous buggy accident in the Bellefonte area, in which one of his arms sustained multiple fractures, which were mismanaged locally. He then went to Philadelphia, where the bones were reset. Not long afterwards, back home, he died of a fever, frequently referred to as typhoid; it seems more likely that sepsis from the mangled arm was responsible.

THE HERBARIUM SINCE PUGH'S DEATH

Soon after Pugh's tragic death, there was a student in the college named William A. Buckhout, who had a keen interest in plants and the science of botany. In 1869–1870 he studied at Harvard with Asa Gray, at that time the most renowned American botanist. In the herbarium there is still a small collection of ancient photos of the great man, certainly keepsakes that Buckhout brought back to Penn State from Cambridge, when he returned in 1871 to become head of the infant Department of Botany and Horticulture. He remained in charge of plant research and teaching at Penn State until his death in 1911 (Fig. 8). Buckhout did not collect many plant specimens for the herbarium, which was a unit of his department. However, one of the collections he did make was of a maple (Fig. 9). That specimen has been important in tracing one aspect of the history of "Dr. Pugh's Herbarium."

For at least sixty years, everyone connected with the Penn State Herbarium has assumed that the handwritten "Evan Pugh" on the label of every sheet of Pugh's herbarium is in fact President Pugh's signature. However, a trained herbarium curator from Guatemala, Ana Lu MacVean, at present a volunteer in the Penn State Herbarium, has begun compiling a list of all Pugh/Bischoff specimens. She inadvertently happened on the abovementioned sheet of *Acer rubrum* (red maple), collected by Dr. Buckhout in 1875, thirteen years after Dr. Pugh's death. The style of label, and the handwriting are identical to that on all of the labels in the Pugh herbarium. More research in the Penn State Archives' examples of Buckhout's and Pugh's handwriting confirms that the labels in "Dr. Pugh's Herbarium" are, in fact, the work of Buckhout. Apparently, about 1875, he decided to improve the condition of the basic Penn State Herbarium by remounting, or in some cases only re-labeling, the specimens from Dr. Pugh. In some instances, especially for the plants that Pugh had obtained from Bischoff and other German botanists, Buckhout cut the labels off the original sheets and glued them on new sheets along with the specimens; he also added a new label with the plant name and the inevitable "Evan Pugh, Heidelberg" (Fig. 6). This procedure seems to be true also for most of Pugh's own collections, although some of the specimens that he collected while in Heidelberg appear to be on the original paper, with a word or two in his own handwriting, but a label prepared by Buckhout. It is interesting that Pugh put his name on only one or two of the books from his library that Penn State still has. The lack of original signatures there and also on his botanical specimens possibly reflects his Quaker-influenced disapproval of emphasizing one's person.



FIG. 8. Dr. Buckhout as he looked around 1900. Although not primarily a plant taxonomist, he was keenly interested in the Penn State Herbarium. He personally re-labeled the entire collection.



AGRICULTURAL COLLEGE OF PENNSYLVANIA.

Acer platanoides L.

(Cult.) Centre Co. Penna.

Coll. Mrs. A. Buckhout, May. 1875.

51677

Pennsylvania
State University
Herbarium

FIG. 9. Specimen of Norway maple, collected by Buckhout in 1875. This label, made 11 years after Pugh's death, and study of Pugh's and Buckhout's handwriting in the Penn State Archives proved that all of the labels in Dr. Pugh's herbarium that appear to be the work of Pugh, as was long assumed, are in fact that of Buckhout. From slight changes in Buckhout's writing, about 1875-1880 seems to be the probable time for his re-labeling work.

Still, it is curious and not really “correct” that Dr. Buckhout failed to indicate on the sheets or apparently anywhere else, that he had so drastically altered the labeling of the specimens. He could have noted on the new labels “information transcribed by WAB/date” or some words to that effect. It must be emphasized in his defense, however, that his work greatly improved the physical condition of the collection. He used high-quality paper, clearly acid-free, probably pure cellulose stock. In many instances one can tell from the transferred labels that the original sheets were prepared using fair to poor paper. Buckhout also must be credited with recognizing the importance of the collection and assuring its permanence at Penn State. His emphasis on the contribution of Pugh by putting the first president's name on every sheet of “Dr. Pugh's European Herbarium” was appropriate and scientifically correct. It should also be noted that at the time of Buckhout's work, few collectors provided much information on their labels.

The existence of Pugh's herbarium, especially the Bischoff specimens, is of considerable interest to German botanists, because many of Germany's herbaria were destroyed or damaged during World War II. One Pugh herbarium specimen has already accidentally turned out to be some sort of type specimen, because all other specimens in Germany of that plant taxon have been lost. According to Professor Doctor Ulrich Kull, distinguished retired botanist from Stuttgart University, many German botanists have recently expressed astonishment that so much of Bischoff's material ended up at Penn State. That was entirely new information to them.

It is somewhat surprising that the Penn State Archives have practically nothing about the history of “Dr. Pugh's Herbarium,” except for its mention in the inventory of the College's meager possessions in 1868. One can deduce that in Dr. Pugh's time and at the beginning of Dr. Buckhout's work, it will have been housed in the original Old Main. When Botany moved to the newly constructed Botany Building (now “Old Botany”) in 1887, Buckhout would have moved the herbarium there, but I have found no specific mention of that event. It is a matter of living memory, that in the 20th century, when Buckhout Building was constructed to house the Biology Department, the herbarium moved there, where it occupied several different locations. In the late 20th century, it moved to various places in the Frear Building and then to its present location in Whitmore Lab.

Much of this moving can be attributed to the fact that, for some decades in the 20th century, natural history collections, including herbaria, were out of favor at universities. They were expensive to maintain and regarded as not for the most part connected to modern developments in science. However, with the realization that herbaria provide banks of DNA, the tide turned in their favor. For example, voucher sheets of pollen- and spore-bearing plants enable palynologists to check the identity of the plants from which slides of the pollen were made, and to study the DNA of the same plant.

An example of such interplay between arboreta—where living, carefully documented plants grow—and herbaria—where expertly dried and pressed, also carefully documented, plants are stored—is a living documented red maple tree (#1031) planted on the Mont Alto campus, when it was the location of the Penn State Forestry School. We have in PAC a specimen of #1031, *Acer rubrum*, in flower, containing abundant pollen, collected in 1948. It would be interesting to collect from tree #1031 again, in flower, to compare the pollen being made now with that made 65 years ago. Have the years of exposure to atmospheric pollution and/or cosmic radiation caused mutations in the tree's DNA that are reflected in the pollen size and/or fine features of the pollen wall morphology? A scientist in the Biology Department at Penn State has shown the potential richness of our herbarium records by germinating a seed from one of the Pugh plants, about 160 years old, and studying the DNA of the resulting seedling. Surely, Pugh would be gratified to know that Penn State is now developing a botanical garden/arboretum. Space will be created and designated to house the herbarium in one of the new structures planned for the arboretum.

In addition to facilitating DNA experiments, the herbarium also provides a convenient venue for paleoecologists to study plant distribution for target areas at times in the past. Our specimens range in age from near 1800 to 2013, and each specimen contains in its dried plant tissues, samples of the carbon and oxygen and other elemental isotopes from each of the represented dates and locations, a potentially rich source of information. Most specimens of herbaceous plants are collected with roots and therefore accidentally with some soil,

which soil can be analyzed in many different ways to get information about the woods of, say, Gettysburg, Adams County, Pennsylvania, in the 1800s.

PAC is a function of the Penn State Biology Department, but has no budget or other funding specifically for its work. Somehow it has survived despite this situation, because of volunteers who have recognized the value of the collection, and help from persons in the university's administration who have recognized both the historic and scientific importance of the collection. As mentioned earlier, an expert, professional volunteer, Ana Lu MacVean, is currently preparing an annotated list of all the sheets of the original, approximately 2,000 specimens of "Dr. Pugh's Herbarium," not an easy task, since they are interspersed with many thousands of other specimens. The heart of PAC is clearly "Dr. Pugh's Herbarium," and that is turning out to have not only importance as a relic of the work of Penn State's scientifically important first president, but also potential biological significance. It incorporates much of the important early 19th century herbarium of Professor Bischoff of Heidelberg University, purchased at auction by Pugh in July, 1856. Many other important collections, such as the Harshberger Herbarium of Trees and Shrubs, which came to PAC from the former Penn State School of Forestry at Mont Alto, have also, especially in recent years, found their way into the Penn State Herbarium.

It would be heartwarming if somehow PAC could be established as "The Dr. Evan Pugh Memorial Herbarium." There is nothing else at Penn State University that has so intimate a connection with the founding of the institution as does this remarkable scientific collection.

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Professor Dr. Ulrich Kull, University of Stuttgart, Germany, assisted the author by getting much information at the sources, about Evan Pugh's years in Europe. Paul Karwacki and Jacqueline Esposito, of the Archives Division of Penn State's library system were of great help in assisting me in use of the archival material on Dr. Pugh in the library. Ana Lu MacVean, who is preparing an annotated list of all specimens in PAC that came to Pennsylvania with Pugh in 1859, was very helpful in passing along information she encountered that was critical to my study. I appreciate the careful reviews of Robert W. Kiger (CM) and an anonymous reviewer.

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